CORRESPONDENCE/MEMORANDUM

State of Wisconsin

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TO: District ERR and Air Management Staff

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SUBJECT: Guidance on Air Sampling and Emission Monitoring at Petroleum Contaminated Soil and Groundwater Remediation Projects.

Changes in the air rules that took affect on October 1, 1994 and September 1, 1995 pertaining to soil and water remediation require that a new guidance memo be drafted. This memo is intended to replace the memos dated April 5, 1991 and May 12, 1992 and combines both ERR and Air Management requirements.

This memo is specific to petroleum contamination cleanups that do not require air permits. Nonpetroleum remediation projects are more complex, the air rules should be consulted for these sites. Pertinent rules for air emission limits and other Air Management requirements are in *NR 406.04, 407.03, 419.07 and 445*. When odors cause complaints, but the remediation appears to otherwise comply with the limits in those rules, the malodor code *[NR 429.03]* may also be applied as an additional restriction.

There have been significant rule and policy changes for some remediation methods, this memo includes all commonly used methods, not just those methods that have limits and restrictions that have changed. For unusual methods not listed here for petroleum sites, call George Mickelson at (608) 267-0858 or Air Management for non-petroleum sites. The primary point of contact in Air Management Central Office is Joe Brehm at (608) 267-7541 for all non-permit issues. Don Faith at (608) 267-3135 is the Central Office Air Management contact for issues pertaining to air permits only.

This memo summarizes the emission limits and other restrictions for commercially operated facilities that are important for consultants and DNR ERR staff to know. This guidance however does not attempt to cover all pertinent requirements for commercial facilities, owners and operators of commercially operated facilities should review the rules. For example, permitting for asphalt plants is not covered in this memo but notification requirements that a consultant must use for shipping soil to an asphalt plant is covered here.

In general, procedures should be used to minimize air emissions during soil handling and transportation *[NR 419.07(4)(a)]*. Also, *NR 718.05(2)(d)* specifies that soil storage piles be covered with an impervious material such as plastic sheeting.

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1.0 Emission Limits by Remediation Method

See Table 1 and the Table Footnotes for specific limits and restrictions in the Air Rules for each remediation method. There are several specific rule interpretations included in the Footnotes to Table 1 that are unique to specific remediation methods. Also, Section 2 of this memo describes important rule interpretations for multiple remediations at single sites.

The Bureau of Air Management has established two zones within the state for air rules pertaining to remediation. One zone has ten counties in the eastern part of the state, the other area is the rest of the state. This memo refers to the "10 County Area" and the "62 County Area." The 10 County Area consists of Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, and Waukesha Counties *[NR 419.07(4)(b, c, d and e)]*. This area covers all of Southeast District (SED) and part of Lake Michigan District (LMD). The 62 County Area covers part of LMD and all other DNR districts.

2.0 Rule Interpretations.

2.1 Contaminant Types, Test Methods and Guidance Memo Applicability.

This memo is specific to petroleum contamination cleanups that do not require air permits. The air rules require that Total VOCs be quantified. There are over a hundred compounds in most petroleum fuels, the majority of those compounds are not quantified in a compound specific analytical scan. Therefore, tests for BTEX, compound specific VOC tests and PVOC scans are not sufficient for complying with the rules. A method that measures all hydrocarbon compounds is necessary. Additional details on test methods for different media are discussed further in Subsections 3.1 through 3.4 in this memo.

Some fuels have minor levels of halogenated hydrocarbons. When the amounts of halogenated compounds that are present are there only because they were additives in fuels, the amount of those compounds is assumed to be negligible. Therefore sites with fuel contaminants that have minor levels of halogenated fuel additives do not need to have those halogenated VOCs quantified.

If however the site had releases of halogenated compounds and petroleum hydrocarbons (Example: A TCE solvent and a fuel oil release), some of the guidance in this memo is not applicable and a site specific review by Air Management may be necessary.

This guidance memo only specifies that Benzene and Total VOC emissions need to be quantified. There are air emission limits for other petroleum compounds (toluene, xylenes, polycyclic aromatic hydrocarbons, etc.) however when the contaminants are fuels and lubricating oils, Benzene and Total VOCs are the limiting factors that need be quantified. If however the contaminants are not typical petroleum mixtures, other tests may apply. For example: A xylene solvent or naphthalene feed stock tank release would need to use different test methods and/or calibration standards than those listed here. Although these are petroleum compounds, this memo is oriented towards the norm, not the exception.

2.2 Control Devices.

In all cases, the stack is the point where the emissions are measured, unless described differently in this memo. Emissions from soil venting systems are not measured at a point before the air enters a control device. This is in part because *NR 406.04(1)(m)* includes the term "considering control devices."

For purposes of the rules, a bleed (or dilution) valve, different sheave wheels, a timer or similar device that operates the system at a slower rate to limit emissions may be used as a control device for unpermitted systems. This

is because the terms "potential to emit" and "capability of" are not used in the rule *[NR 419.07(4)]*.

A bleed (or dilution) valve, different sheave wheels, timers, etc. however may not be used as a control device for systems permitted under *NR 406.04 or 407.03* because those codes include the language "potential to emit."

A groundwater extraction system however must be operated at a sufficient rate to contain the plume. The ERR program considers a reduction in groundwater extraction rate below that necessary to capture the plume to be an unacceptable method of reducing air stripper emissions.

2.3 Sources and Site Locations.

The emissions are summed for all remediation systems on-site to determine total emissions. Sources at a site that are not associated with soil and groundwater remediation are not included in the Total VOC limit for compliance with *NR 419.07*, however all sources (both remediation and non-remediation sources) are summed for compliance with *NR 445* (benzene emissions).

The site, as that term is defined in *NR 700.03(56)* is used for compliance with rules for Total VOC emissions, even if multiple air emission sources are on multiple properties. For example: If a site has two soil venting systems, one on each side of the road or property line, emissions from both of the soil venting systems are summed for measuring compliance with *NR 419.07* for Total VOCs. The rule interpretation is the same for determining compliance with *NR 445* for benzene emissions, unless non-remediation sources are included in the benzene total. In that case a site specific review may be necessary by Air Management.

If however some soil is shipped off site for treatment at a commercially operated facility, the emissions from off site soil treatment are not applied to the site total. For example: If there is an air stripper for groundwater treatment on site, and soil is shipped off site to a thermal treatment system, the air stripper emissions occur at the site, the thermal treatment system emissions occur off site at the location of the permitted thermal treatment unit.

According to *NR 419.07* landspreading is limited to on-site remediation or other projects conducted under the solid waste codes (*NR 419.07(4)(e)3.*). In preparation for the DNR reorganization, on June 15, 1995 the Bureau of Solid and Hazardous Waste made a policy decision to allow off-site landspreading without *NR 502 or 518* approval. For more information, refer to the DNR guidance on landspreading petroleum contaminated soil (to be released in September 1995). It is anticipated that *NR 419.07(4)(e)3.* will be changed in late 1995 or early 1996 along with other changes to *NR 718* to reflect this policy change.

For purposes of *NR 419.07*, the location that the soil is landspread is the point where the emissions occur. Therefore, the emission limits will be applied to the property where the soil is landspread, whether it is on-site or off-site. When landspreading is conducted off-site, the on- and off-site totals for VOCs are not summed to measure compliance because each location has separate allowable totals.

2.4 Start Time for Contaminants With Annual Limits.

Benzene emission limits are annual limits. An air emission control device is needed if the benzene emission rate will be greater than 300 pounds per year *[NR 445]*. A daily or monthly rolling average is not used. For purposes of this rule, the year starts when the initial remediation system is started up. For example: It is not allowable to emit 300 pounds in December and another 300 pounds the following calendar year. District Air Management staff may however specify that a calendar year is used on a site specific basis.

2.5 Permits.

A construction permit is needed if the emission rate will be greater than 5.7 pounds per hour of Total VOCs *[NR 406.04]*. If the system is ever operated above 5.7 pounds per hour of Total VOCs, a permit and possibly a control device may be necessary. Therefore, the consultant should use an appropriate safety factor during operation to assure that the system never exceeds 5.7 pounds per hour Total VOCs. No specific numerical safety factor is recommended, the fluctuations in the extraction rate for a typical remediation system are very site specific and require professional judgement to estimate.

An operation permit is also needed if the emission rate of the system will exceed 5.7 pounds per hour of Total VOCs 18 months after startup *[NR 407.03]*.

2.6 Emergency Conditions and Unusual Situations.

If necessary to prevent an emergency condition which threatens public health, safety or welfare, Air Management may waive any requirements within *NR 419.07* of the air rules *[NR 419.07(8)]*.

There are several exemptions that are not listed in this memo due to their rarity. These include: dewatering systems for construction *[NR 406.04(m)7. and 419.07(3)(b)]*, municipal water supply treatment *[NR 406.04(m)6. and 419.07(3)(a)]*, crop irrigation systems *[NR 406.04(m)7. and 419.07(3)(b)]*, certain systems that operate for less than 3 months *[NR 406.04(m)2., 8. and 9.]*, ERP funded sites and Superfund sites *[NR 406.04(m)9.]*, etc. Refer to the rules for more information on this.

3.0 Approved and Recommended Test Methods.

There are three types of testing typically conducted on soil and water remediation projects, as follows:

- Compliance Testing. Compliance testing is testing that is conducted to determine compliance with the air rules. This testing includes tests for Total VOCs and Benzene at the point of the emission source, which is typically the stack. Test methods, other than those listed in this memo for measuring for compliance purposes must be approved by Air Management.

- Performance Testing. Performance testing is used to measure performance of a remediation system for optimization during operation. Performance tests are typically conducted at internal points on the system that may or may not be emission points (Example: Each well on a soil venting system). Tests for gases that are not regulated by Air Management (Example: Oxygen, carbon dioxide, methane, etc.) also fall into this category.

- Other Tests for Safety. Safety tests are tests that are specific to operating a remediation system in a safe manner (Example: Using a combustible gas meter on a soil venting system stack to assure that the gases emitted are below the lower explosive limit).

For the convenience of consultants and DNR ERR staff, this memo lists all three types of testing for commonly used remediation methods to make it easier to plan a system design and monitoring plan. Whenever possible, the same methods and procedures should be used throughout the life of the project to minimize biases (due to method changes) from affecting system performance trends.

3.1 Test Methods for Air Samples.

Acceptable analytical and field tests for different parameters are as follows:

- Benzene in Air. Granular activated carbon tubes or similar adsorptive media for laboratory testing, field GCs or laboratory tests of bag samples are all acceptable for compliance testing. Most laboratories that conduct these tests have developed their own procedures. If possible, EPA Method 18 should be used for analyzing benzene. Air Management does not specify a specific method for laboratory analysis.

- Total Vocs in Air. Air Management has a preference for EPA Method 25A for analyzing stack emissions for total organic compounds when used for compliance testing. For performance testing, other methods include: flame ionization detectors (FIDs), field GCs, photoionization detectors (PIDs) that have a 10.6 or higher eV lamp, or laboratory analysis of bag samples or carbon tubes. Carbon tubes (or other adsorptive media) for Total VOCs are acceptable, but are not recommended due to the high cost of laboratory analysis. When converting ppm_v readings to a mass per time basis, assume a molecular weight of 95 for gasoline.

  There is a serious drawback to using PIDs, they suffer from "quenching" where high levels of contaminants cause the instrument to underestimate the concentration of VOCs in the air. Also, PIDs vary in sensitivity to different compounds much more than FIDs, for example a PID that is calibrated to benzene only reads 22 percent of the actual concentration of hexane. Also, when a 10.6 eV lamp is used, some compounds are not measured. For these reasons, FIDs or other methods are strongly encouraged over PIDs.

- Oxygen in Air. Methods include a combustible gas/oxygen deficiency meter, landfill meter, or respirometers. Laboratory tests are also acceptable. If colorimetric tubes (Drager, Sensidyne or similar) are available, they are also acceptable. This parameter is used for performance testing only.

- Carbon Dioxide in Air. Methods include Drager or Sensidyne tubes, respirometers or landfill gas meters. Carbon dioxide may also be measured by a laboratory. This parameter is used for performance testing only.

- Methane in Air. Under certain anaerobic processes, methane is generated. When methane testing is used for monitoring bioventing, instruments include a landfill gas meter or an FID that is equipped with a granular activated carbon prefilter. The carbon filter on an FID is used to remove all hydrocarbons other than methane prior to the air sample entering the instrument. Laboratory testing for methane is also an option. This parameter is used for performance testing only.

- Lower Explosive Limit. Combustible gas meters are used for this purpose. This parameter is used for safety testing only.

3.2 Test Methods for Water Samples.

Water samples are used in some situations to estimate air emissions for compliance purposes. For example, instead of measuring air samples from an air stripper used for water treatment, estimating air stripper emissions is by calculating a mass balance based on water sample results.

- Benzene in Groundwater. Any method that is listed in the *LUST Analytical Guidance*, WPDES permit, or other water discharge permit/approval for the site.

- Total VOCs in Groundwater. GRO and/or DRO (whichever is applicable for the site).

3.3 Test Methods for Soil Samples.

Soil samples are used to estimate total emissions for compliance purposes for some remediation methods.

- Benzene and Total VOCs in Soil. Use the analytical methods specified in the *LUST Analytical Guidance*, for benzene (PVOCs) and Total VOCs (GRO and/or DRO).

When soil samples are used to estimate the total mass of the contaminants or to determine if the average contaminant concentration is above or below 250 mg/kg, all soil sample results are used. *NR 419.07(4)(f)* specifies that the average concentration is *"... determined by averaging the contaminant concentrations in all samples of the contaminated soil or water analyzed and multiplying that average by the total amount of soil or water to be remediated."* For that reason, it is not acceptable to select certain soil sample results to calculate a lower average concentration. That method of diluting the average concentration to below 250 mg/kg is not allowed.

3.4 Other Air Tests.

- Air Flow Rate. These are usually pitot tubes, averaging pitot tubes, venturi meters, or orifice plate meters. Rotameters may also be used, but have high flow restriction. Other meters such as vane type meters are also acceptable. When pitot tubes and averaging pitot tubes are used, they generally require an air velocity through the pipe that is at least 1,000 feet per minute to read accurately, the pipe diameter may need to be sized to the design air velocity to provide accurate readings. Flowmeters should be selected and installed to manufacturers recommendations for both up and downstream unobstructed pipe lengths adjacent to the meters.

- Vacuum. Typically vacuum gauges or differential pressure gauges (Magnehelics) with one port open to atmosphere are used. Manometers may also be used, but if filled with water may freeze during winter. Units should be in inches of water column or mercury with 2 digits of accuracy.

- Air Temperature. Thermometers are used to measure the temperature of the air stream. Typically a bimetal dial type thermometer is used. Thermocouple type meters are also acceptable (if intrinsically safe).

- Dew Point. Dew point is primarily used for evaluating moisture loss from bioremediation systems. It also is used to assess the air stream compatibility with GAC or other off gas treatment. All sampling equipment and tubing must be as warm or warmer than the dew point, otherwise condensation occurs which causes an inaccurate result. There are no recommended methods, electronic dew point meters and wet bulb thermometers are options.

4.0 Method Calibration.

4.1 Laboratory Methods.

Laboratories should use a calibration method that is either approved by the U.S. EPA or approved by the DNR Bureau of Air Management.

4.2 Field Instrument Calibration.

Calibration of field instruments should be to manufacturers specifications. Recommended standards for different instruments are as follows:

- FID Calibration. FIDs should be calibrated with a hexane standard, not methane. If the instrument is calibrated to methane, a conversion factor recommended by the manufacturer is acceptable.

- PID Calibration. PIDs should be calibrated with an isobutylene standard. If the instrument is calibrated with a benzene standard, a conversion factor recommended by the manufacturer is acceptable.

- Field GCs. When a field GC is used for estimating Total VOCs as gasoline, the consultant should propose a calibration standard and method to Air Management prior to testing.

- Other Instruments. Other meters (combustible gas meters, oxygen, etc.) should be calibrated to manufacturers recommendations and specifications.

5.0 Field Procedures and Sample Storage.

All instruments and meters that use electronics should be classified as intrinsically safe or explosion proof. In addition to meters that measure different components of air, this includes heated wire anemometers, electronic thermometers, dew point meters, etc. This is intended to minimize the potential for catastrophic events.

Sampling procedures, storage and handling requirements are as follows:

- Soil and Water Samples. Soil and water samples should be collected, shipped, stored and analyzed according to the *LUST Analytical Guidance* (1993) and any updates, the *Guidance for Conducting Environmental Response Actions* (1992), and the DNR *Groundwater Sampling Procedures Guidelines* (1987).

- Adsorptive Media Samples. Air samples that are collected on adsorptive media (carbon tubes, etc.) should be collected, stored and shipped according to procedures recommended by the laboratory that will run the samples. At a minimum, the samples should use the same storage and holding time criteria for soil samples (4°C and no more than 14 days).

- Air Samples. Air samples that are stored as air samples in containers and shipped to the laboratory should have a holding time no longer than 48 hours. Any container that is commercially available and specifically designed for air samples is acceptable. Teflon coated septa are highly recommended to reduce hydrocarbon adsorption on the septa.

  If air samples in Tedlar bags are to be shipped by air transport, the bags should not be full, or they may burst due to the lower atmospheric pressure in the airplane.

  Tedlar bags frequently leak. When tedlar bags are used, two samples should be collected, the analysis with the higher result should be used for measuring compliance with air rules.

- Sampling with Field Instruments. When field instruments are used to sample air at a sample port that is under negative or positive gauge pressure, the air sample must be transferred to a container that can deliver the sample to the instrument under atmospheric pressure. Generally, a small hand pump is used to transfer the sample to a Tedlar bag. This extra step is used because an instrument that is directly connected to a source that delivers an air flow rate that differs from the flow rate used during instrument calibration usually provides inaccurate instrument readings. If the Tedlar bag is fully evacuated between samples, has no condensate in it, and is

purged with clean air between samples, it may be reused at other sampling locations.

When field instruments are used to sample air under atmospheric pressure, there is no single recommended procedure.

- Sampling Gas Probes. Air samples that are collected from gas probes and water table wells should have a minimum of 3 to 5 air volumes purged from the well/probe prior to sampling. These sampling points must be capped when they are not used to prevent clean air from being drawn into the soil by the vacuum from the soil venting system. Otherwise the sample only reflects the air quality of the air that was drawn into the soil a few minutes before sample extraction.

6.0 Predesign Testing.

Prior to design and installation, on site tests are conducted for specific remediation methods.

6.1 Prior Testing for Groundwater Treatment by Air Stripping.

Estimating air emissions by an air stripper prior to installation are as follows:

- Water samples are collected from the recovery well(s) and analyzed for Benzene and Total VOCs.
- Hydraulic conductivity (or transmissivity) tests are conducted and plume capture calculations are prepared to estimate the groundwater extraction rate that is necessary from the well(s) to capture the plume.
- That data is then used to estimate the rate that Benzene and Total VOCs are removed from the well(s).

Sample results from the most recent sample event should be used, unless those sample results are obviously in error.

For this purpose, monitoring well data is not recommended, these wells are not installed at the groundwater extraction point and could result in an inappropriate air stripper design.

6.2 Predesign Testing for Soil Venting Systems.

Estimating soil venting system emissions for notification are as follows:

- A pilot test is conducted on a test well(s) near the center of the contaminant source area.
- Air samples are collected at the well or the piping before any bleed or throttle valves. Also at this point, vacuum, temperature and air flow rate is measured when samples are collected.
- Total VOC samples should be collected during the pilot test every half hour when field instruments are used.
- Benzene samples should be collected at least twice during the pilot test.
- Lower explosive limit is measured at the stack to determine if it is safe to continue the pilot test. A bleed valve or other device may be necessary to reduce the air extraction rate to assure that explosive levels are not emitted.

- Carbon dioxide and oxygen measurements are optional. If measured, these gases should also be measured at a background point. Suitable background points include an upgradient "clean" monitoring well or a soil gas probe in a uncontaminated location. Oxygen measurements are more appropriate than carbon dioxide.

6.3 Predesign Testing for In Situ Air Sparging.

When in situ air sparging is to be coupled with a pilot test for soil venting, in addition to the information in Subsection 6.2, the following is also applicable:

- The soil venting pilot test is conducted for at least one hour (preferably a few hours) before air is injected into the aquifer to establish a base line of air contaminant levels without sparging. Air sparging is then tested for at least 2 hours (preferably 4 or more) to evaluate extracted air concentrations with sparging. Ideally, the test sparging well(s) location is in a zone of high contamination levels.

- At least 2 air samples for benzene should be collected under soil venting alone and at least 2 with air sparging. Since the lag time from the start of air injection until the injected air is extracted (by the venting system) can be many hours, the benzene samples should be collected late in the sparging test.

- After air sparging is started, emission rates can increase substantially. Therefore, LEL measurements should be taken at the stack routinely during the entire test for safety purposes.

6.4 Testing Before Excavation for Soil Remediation.

When soil is to be excavated for thermal treatment, biological treatment, disposal, landfarming, thinspreading, or asphalt incorporation, soil samples for GRO and/or DRO (whichever is applicable) and soil samples for benzene are collected during the site investigation. A Total VOC and total benzene mass is then estimated for purposes of Form 4400-120.

As discussed in Subsection 3.3, dilution is not authorized to lower the average concentration of some soils to below 250 mg/kg.

6.5 Predesign Testing for Other Methods.

Sampling for other remediation methods are determined on a case by case basis.

7.0 Prior Notification to Air Management and Form 4400-120 Submittal.

Air Management must be notified prior to the remediation. A remediation may commence ten business days after the postmark of the notification *[NR 419.07(2)]* (i.e. no written response from Air Management is required to commence remediation). Air Management staff may approve or deny a remediation during this 10 day period or at any time after. The submittal to Air Management however must be COMPLETE. If the remediation proceeds and the submittal was not complete, Air Management may issue a Notice of Violation later when the application is determined to be incomplete. Even though a remediation system proceeds without approval, the emission limits must not be exceeded. Air Management notification is made on Form 4400-120. Forms are submitted to the Air Management Program in each district, unless specified otherwise. A copy of the new Form is attached. A copy of the notification Form and any calculations should also be sent to the DNR ERR Project Manager. If the site is not managed, the notification should be sent to the ERR program in the appropriate district.

8.0 Startup and Operation on Continuous Operation Systems.

Once the remediation system(s) is installed, startup and operation of the system(s) is as follows:

8.1 Startup and Operation of Air Strippers.

Air stripper emissions that do not have air emission control should be monitored as follows:

- Stack testing is not recommended, instead a calculated mass balance on water samples is recommended.
- Water samples from an air stripper inlet and outlet, coupled with the water flow rate are used to calculate the amount of Total VOCs and benzene that are emitted by the air stripper.
- If a GRO/DRO test is not needed at the air stripper outlet for WPDES or POTW requirements, it can be assumed that 100 percent of the VOCs that enter the air stripper are emitted to the atmosphere for purposes of the calculations. This may reduce sampling costs because only the air stripper influent needs to be tested, not the effluent.
- If the water flow rate through the air stripper is less than approximately 35 gpm, it can be assumed that the Total VOCs are below 5.7 pounds per hour because petroleum fuels are unlikely to be soluble enough to deliver over 5.7 pounds per hour in the dissolved phase to the air stripper. Sampling for Total VOCs (but not Benzene) can be neglected in this case for Air Management purposes, however this does not waive any requirements for WPDES permitting.
- Recommended sampling frequency for Total VOCs and Benzene is during sampling for other permitting authorities (Wastewater Permits, POTW Approvals, etc.) which is typically monthly.
- See Section 9.0 for reporting requirements for the first three months of operation.

8.2 Startup and Operation of Soil Venting Systems.

Soil venting systems and forced air biopiles (biopiles that use a blower) that do not have air emission control should be monitored as follows:

- Lower explosive limit is measured at the stack to determine if it is safe to operate upon startup. Once the system is operating at an emission that is below the LEL, these measurements can be neglected. A bleed valve or other device may be necessary to initially reduce the air extraction rate to assure that explosive levels are not emitted.
- Total VOCs at the stack are sampled daily for the first 3 days of operation, weekly for the next 3 weeks, and monthly thereafter for compliance testing *[NR 419.07(6)(a)1.a.]*. If emissions are substantially below 5.7 pounds per hour, after one year, permission from Air Management may be sought to reduce sampling frequency to once a quarter.
- Benzene at the stack is sampled once during the first 3 days of operation, during the 3rd week, and every 6 months thereafter *[NR 419.07(6)(a)1.b.]*. If benzene samples during the first year demonstrate that the emission rate is substantially below 300 pounds per year, permission may be sought from Air Management to drop benzene sampling. If the system will operate at or near the 300 pound per year rate, more frequent sampling for benzene is highly recommended to assure that the limit is not exceeded.

- Total VOCs (but not Benzene) at each air extraction well and gas probe is collected weekly for the first 3 weeks of operation, and monthly thereafter for performance testing.

- Carbon dioxide, oxygen and possibly methane measurements may be collected at each air extraction well and a background point approximately every 3 months to qualitatively evaluate biodegradation processes. This data may then be used to qualitatively estimate biodegradation rate, see Example 1.

- See Section 9.0 for reporting requirements for the first three months of operation.

  Any reduction of sample frequency for performance testing should be approved by DNR ERR staff on managed sites. If the Benzene and Total VOC emissions are substantially below the emission limits, sampling frequency can be reduced with prior written approval (not notification) by Air Management.

8.3 Startup and Operation of In Situ Air Sparging Systems and Soil Venting Systems that Use Forced Air Injection.

In addition to the sampling requirements in Subsection 8.2 for soil venting systems, additional sampling in gas probes and water table wells for Total VOCs and vacuum/pressure near any structures that could accumulate vapors (buildings, sewers, etc.) is necessary. This is intended to assure that there are no unsafe levels of vapors AND that the subsurface air is under negative (NOT positive) pressure near these structures.

8.4 Startup and Operation of Other Remediation Methods.

Monitoring programs for other remediation systems are determined on a case by case basis. If the soil is treated by an facility that has an air permit, the monitoring program is established as part of the permits.

9.0 Post Startup Reporting and Record Keeping.

Once remediation commences, reporting results for the first three months of operation to Air Management must be within 60 days following the end of that time period *[NR 419.07(6)(a)4.]*. These reports are sent to the same office as the notification forms for that site. Further reports to Air Management after that report are not necessary. There is no form for operation reporting, a very brief letter with attachments is appropriate.

When soil is treated or disposed by a facility that has an air permit (landfills, asphalt plants, thermal treatment systems, etc.) or a commercially operated bio-treatment facility, the consultant does not need to follow up after remediation with reports to Air Management. The facility is instead responsible for reporting emissions.

Records and calculations must be kept for three years for the amount of Benzene and Total VOCs emitted and the amount of soil or water that was remediated *[NR 419.07(7) and NR 439.04]*. A summary of the records to keep include: date of testing, procedures for testing, calculations, test results, calibration and maintenance procedures, schedules of maintenance and calibration of testing equipment, records of testing equipment used, company(s) conducting the tests, and any other relevant data. Records are stored at the consultant’s office in most cases, however they may be stored at the site instead. If the soil is remediated by a facility with an air permit or a commercially operated bio-treatment facility, the records are instead stored by that facility. *NR 439.04* includes the specific list of required data, if in doubt refer to the rule for more details.

Table 1
Air Emission Limits, Restrictions, and Air Management Rule References for Soil and Groundwater Remediation Projects Under the NR 400 Series of Rules

	Total VOC Limit 10 County Area(1)	Total VOC Limit 62 County Area(1)	Benzene Limit All Sites(2)
Unpermitted Air Strippers Without Emission Control(3)	5.7 Pounds/hour *NR 419.07(4)(b)1. and NR 406.04(1)(m)*	5.7 Pounds/hour *NR 406.04(2)(c)*	300 Pounds/year *NR 445*
Permitted Air Strippers Without Emission Control(3)	5.7 Pounds/hour *NR 419.07(4)(b)1.*	9 Pounds/hour total *NR 419.07(4)(b)2.*	300 Pounds/year *NR 445*
Air Strippers With Emission Control	5.7 Pounds/hour *NR 419.07(4)(b)1.*	5.7 Pounds/hour without a permit *NR 406.04(2)(c)* 9 Pounds/hour with a permit *NR 419.07(4)(b)2.*	300 Pounds/year *NR 445*
Unpermitted Soil Venting Systems(3,4)	5.7 Pounds/hour *NR 419.07(4)(b)1. and NR 406.04(1)(m)*	5.7 Pounds/hour *NR 406.04(2)(c)*	300 Pounds/year *NR 445*
Permitted Soil Venting Systems(3,4)	5.7 Pounds/hour *NR 419.07(4)(b)1.*	9 Pounds/hour *NR 419.07(4)(b)2.*	300 Pounds/year *NR 445*
Soil Venting Systems With Air Emission Control(4)	5.7 Pounds/hour *NR 419.07(4)(b)1.*	5.7 Pounds/hour without permit *NR 406.04(2)(c)* 9 Pounds/hour with a permit *NR 419.07(4)(b)2.*	300 Pounds/year *NR 445*
Soil Venting Pilot Tests(4,5) (up to 150,000 scf total)	No limit *NR 419.07(3)(d)*	No limit *NR 419.07(3)(d)*	300 Pounds *NR 445*
Covered Passive Ventilation Biopiles(6)	NA (See note 6)	NA (See note 6)	NA (See note 6)
Landspreading(7)	2,000 Pounds/year *NR 419.07(4)(e)1.*	6,000 Pounds/year *NR 419.07(4)(e)2.*	300 Pounds/year *NR 445*
Thermal Treatment and Asphalt Incorporation(8)	Comply with air permit	Comply with air permit	Comply with permit
Bio-Treatment With NR 502 Approval(9)	NA (See note 9)	NA (See note 9)	NA (See note 9)
Landfill Disposal(10,11)	See notes 12 and 13 *NR 419.07(4)(d)1.*	See notes 13 and 14 *NR 419.07(4)(d)2.*	See note 15 *NR 445*

Footnotes to Table 1:

1. The 10 County Area consists of Kenosha, Kewaunee, Manitowoc, Milwaukee, Ozaukee, Racine, Sheboygan, Walworth, Washington, and Waukesha Counties. The 62 County Area is the rest of the state *[NR 419.07(4)(b, c, d and e)]*.

2. 300 pounds per year benzene is specified, in the unlikely situation where this is unachievable, 95 percent destruction by a treatment device may be used instead.

3. The term "Permitted" or "Unpermitted" refers to remediation systems that have or do not have air permits issued under *NR 406 and/or 407*. It does not refer to other DNR permits/approvals.

4. Soil venting is a broad category that includes: Soil Vapor Extraction (SVE), Bioventing, combined Vapor Extraction/Groundwater Extraction (VE/GE), air extraction systems associated with In Situ Air Sparging and Forced Air Biopiles. Because the rule language uses the term "negative pressure venting of contaminated soil" *[NR 419.07(6)]*, all of these systems use the limits specified for soil venting systems. Sampling frequency for all types of soil venting systems for Total VOCs is daily for 3 days, weekly for the next 3 weeks and monthly thereafter. For Benzene it is once during the first 3 days, the third week, and every 6 months thereafter *[NR 419.07(6)(a)1.]*.

5. Pilot tests for all types of soil venting systems are exempt from permitting, notification and hourly Total VOC limits, but are not exempt from the 300 pounds per year benzene limit. A pilot test may emit up to 150,000 standard cubic feet of air. To emit over 150,000 standard cubic feet, requirements for notification and hourly VOC limits apply. Only negative pressure soil venting systems (both in situ and ex situ) are eligible for the exemption *[NR 419.07(3)(d)]*.

6. Covered Passive Ventilation Biopiles have no blower to extract air. All air exchange is through convection and diffusion processes that typically are sufficiently slow that an average air flow rate is unmeasurable. Because an average air flow rate cannot be accurately measured, there is no limit in the amount of VOCs that can be placed and remediated in this type of biopile. If however the biopile is not covered with an impervious plastic cover, then the limits used for landspreading apply instead.

7. The air rules do not differentiate between Landfarming (no impervious base) and Thinspreading (on an impervious base). Both methods have the same limits in the Air Rules *[NR 419.07(4)(e)]*. When Landfarming or Thinspreading is used, it is assumed that all benzene and Total VOCs in the soil is emitted to the atmosphere within one year after the soil is placed.

8. Thermal Treatment and Asphalt Incorporation have emission limits that are specified by air rules and the air permit issued to the facility. These facilities have no limits in the air rules on the level of contaminants or volume of soil that they can accept from any given contaminated site for treatment.

Footnotes to Table 1, continued:

9. Biological Treatment Facilities that use forced air biopiles and are approved by the Solid Waste Section under *NR 502* have the same air emission limits specified for soil venting systems. These facilities have no limits in the air rules on the level of contaminants or volume of soil that they can accept from any given contaminated site.

10. For estimating the contaminant mass in soil, the Air Rules specify that an average value is used, not a maximum concentration *[NR 419.07(4)(f)]*. The average is obtained by averaging all soil samples. For this requirement, GRO and DRO (if both are analyzed) should be summed together. Air Management does not allow highly contaminated soils to be diluted with "cleaner" soils for purposes of lowering the "average" level to 250 mg/kg. In other words, the soil should not be separated into "under 250 mg/kg" and "over 250 mg/kg" categories for separate handling or different remediation methods.

11. The air rules do not have a volume limitation on the amount of soil that can be placed in a landfill from any single site, however *NR 722* does. Refer to *NR 722* for more information.

12. Landfill disposal in the 10 County Area is limited to soil that contains less than 250 mg/kg Total VOCs *[NR 419.07(4)(d)1.b.]*. The air rules allow a landfill to instead comply with the hourly emission rate of 5.7 pounds per hour instead of the 250 mg/kg restriction, however at the time this memo was written, no landfills have been approved for this option.

13. If the landfill treats the soil under a *NR 502* approval before it is placed into a landfill, there is no limit to concentration or mass that can be accepted for treatment. In this case, the post treated soil must be below 250 mg/kg in the 10 County Area, unless the *NR 502* approval is written more stringently. In the 62 County Area, post treated soil that is below 250 mg/kg is not subject to air rules in *NR 419.07(4)(d)2.c.*

14. Landfills in the 62 County Area use a complex set of regulations to determine the limit of soil and contaminant levels that any individual landfill can accept *[NR 419.07(4)(d)2.]*. It is possible that different landfills will operate under different options listed in the rule. For that reason, consultants should contact individual landfills for criteria for acceptance at that particular landfill.

15. The benzene limit that can be placed in any landfill in the state is 300 pounds per year *[NR 445]*. This total includes the benzene in soils that contain less than 250 mg/kg GRO and/or DRO. If soil is treated to less than 250 mg/kg Total VOCs prior to placement in the landfill, the benzene that remains in that treated soil is also included in the 300 pounds per year total.

Example 1
Example Calculations for Estimating Biodegradation Rate on Soil Venting Systems

Assumptions for the example:

- The measurements at the air extraction well are as follows:
  - Average air flow rate is 100 scfm.
  - Average oxygen level extracted is 18.5 percent by volume.
- Background air measurement in an upgradient uncontaminated gas probe or water table well is 20.0 percent oxygen by volume.
- Atmospheric air weight is 0.0763 pounds per cubic foot at standard temperature and pressure, average molecular weight of air is 28.97 which is rounded off to 29, average molecular weight of O_2 is 32.
- For every pound of contaminants biodegraded, 3.3 pounds of oxygen is utilized.

Sample calculations:

Oxygen utilization rate:

$$(0.20 - 0.185) * \frac{32}{29} * 0.0763 \frac{lbs}{ft^3} * 100 \frac{ft^3}{min} * 60 \frac{min}{hr} =$$

= 7.58 pounds of oxygen per hour is utilized for biodegradation

Biodegradation rate based on oxygen:

7.58 / 3.3 = 2.3 pounds of hydrocarbon biodegraded per hour

Notes:

- The calculated biodegradation rate is likely to underestimate the actual biodegradation rate. The rate estimate is based on oxygen utilization which measures biodegradation of all carbon sources, including natural organic carbon.
- Also, the air in the background monitoring point is nearly stagnant, much more so than within the air flow regime of the venting system. If the soil contains a significant amount of natural total organic carbon, it is possible that natural biodegradation of natural carbon sources in a nearly stagnant background monitoring point will result in an oxygen deficiency that exceeds the oxygen deficiency within the area of the venting system. In other words, the air measured in the background point is not representative of the air entering the contaminated soils.
- If the background oxygen level is lower than the oxygen level in the extracted air, calculating a biodegradation rate with this method is not recommended. The calculated rate will be negative which is obviously inappropriate.